

Identifying designer needs: Applying customer needs analysis and human-computer interaction methods to a design repository.

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Objectives:

Today there are several formal design methods in existence to support conceptual and redesign efforts. Additionally, there are several computational tools that draw from formalized design methods. In particular these methods can be seen within design repositories, product data management systems and traditional CAD packages. The goals of this research are to identify the hurdles of merging design theory and software design techniques and to formulate a usable software interface to meet the needs of designers. Designing an effective user interface requires cooperative efforts of both design theorists and human computer interaction experts in designing useful and usable software tools.

Methods:

One hurdle in making formal methods useful is the need to represent design in a particular formalism. We approach this problem from both the design theory and the software usability sides. Specifically, studies are conducted on two fronts: 1) to determine which design activities within the general framework of function-based design, provide the greatest insight to practitioners; and 2) to propose and rate software task requirements that are harmonious with the design process. From the design theory side, we determine what minimal sets of information are sufficient to specify a model within a design formalism. From studying the work practices of design engineers, we can determine what information, design representations and conceptual structures a design engineer already uses in their day-to-day practice. Combining these two sets of information allows for generation of appropriate software tools to facilitate design fluency.

We use an existing computational tool for function-based conceptual design known as the Design Repository (Bohm and Stone, 2004) as the forum for design activities in this study. The Design Repository is a heterogeneous collection of product design knowledge (stored in a database) that can be searched and re-used to produce design tools such as morphological matrices and design structure matrices during conceptual design.

A task-centered approach is taken to design the user interface (Hackos and Redish, 1998). Our first step is to understand the design engineers' activities and break these down into particular tasks that need to be performed by the engineer. These tasks are determined both by the design methodology, and the engineer's context and work practice. These prototypes are evaluated by user interface usability experts and also by the actual users in a participatory design process (Blomberg and Henderson, 1990). Practicing design engineers are used to bring insight to the design

process that cannot be achieved through introspection alone. Usability studies are conducted through the use of "paper prototyping," as in Rettig (1994), wherein designers and users are presented with initial sketches of proposed user interface features. A roundtable discussion in the spirit of creative techniques like the 6-3-5 Method provides a forum for designers, including end users, to markup the proposed user interfaces (Otto and Wood, 2001). Feedback gathered from the initial brainstorming session is then used to modify and reduce the number of base sketches. A second brainstorming session is used to bring forward final interface candidates for ranking.

Results:

Key results of this research include a methodology for transforming formal design methods to usable software tools; a user interface for bridging formal design and usable design tools; and a prototype for a software tool are developed.

Conclusions:

Computational tools based on formal design methods can be designed so that the designer gains the power of using formal methods without the burden of explicitly creating the underlying formalisms. This study also indicates when a software tool may be useful in the engineering design lifecycle.

Keywords: Usability, Interaction Design, Design Methodologies, Design Repository, Conceptual Design Tool

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